

MINISTRY OF
LABOUR AND NATIONAL SERVICE

Joint Standing Committee
on
Safety, Health and Welfare Conditions
in
Non-Ferrous Foundries

Second Report



LONDON
HER MAJESTY'S STATIONERY OFFICE
1959

MEMBERS OF COMMITTEE

Mr. H. Woods¹

H.M. Deputy Chief Inspector of Factories (Chairman)

Employers' Representatives

Mr. P. B. Higgins² } Nominees of the Association of Bronze and Brass

Mr. W. T. Hobkirk, J.P. } Founders³

Mr. F. G. Burrell, O.B.E. } Nominees of the Engineering and Allied Employers'

Mr. C. E. Watson } National Federation

Mr. A. Graham } Nominee of the Light Metal Founders' Association

Mr. J. H. Barwell, J.P. } Nominees of the National Brass Foundry Association

Mr. L. W. Gummer }

Mr. A. E. Mills⁴ } Nominee of the Zinc Alloy Die Casters Association

Trade Union Representatives

Mr. H. G. Barratt⁵—Nominee of the Confederation of Shipbuilding and Engineering Unions

Mr. F. Bullock⁶—Nominee of the Amalgamated Union of Foundry Workers

Mr. J. H. Wigglesworth, O.B.E.—Nominee of the Iron, Steel and Metal Dressers' Trade Society

Mr. F. W. Winslade—Nominee of the National Society of Metal Mechanics

Mr. G. W. Chilton—Nominee of the North of England Brass, Aluminium, Bronze and Kindred Alloys Moulders' Trade and Friendly Society

Mr. C. W. Hallett⁷—Nominee of the Amalgamated Engineering Union

Mr. L. R. Kealey—Nominee of the Transport and General Workers' Union

Independent Member

Mr. J. Gardner

H.M. Factory Inspectorate Representatives

Dr. W. D. Buchanan⁸—H.M. Deputy Senior Medical Inspector of Factories

Mr. W. B. Lawrie,⁹ M.B.E.—H.M. Engineering Inspector of Factories

¹ Succeeded Mr. R. Bramley-Harker in February, 1958.

² Succeeded Mr. G. Hyslop in March, 1957.

³ Mr. E. Ayres attended many meetings as deputy nominee.

⁴ Appointed in November, 1957.

⁵ Succeeded Mr. Gavin Martin in November, 1957.

⁶ Succeeded Mr. J. Gardner in October, 1958, as a nominee of the A.U.F.W.

⁷ Succeeded Mr. J. M. Boyd in July, 1957.

⁸ Succeeded Dr. A. I. G. McLaughlin in July, 1957.

⁹ Also acted as Secretary from June, 1958.

CONTENTS

	<i>Page</i>
Introduction	iv
Report of the Joint Standing Committee	1
Report of the Technical Sub-Committee	3
General Considerations	4
Dust	5
Fumes	5
Other Health Precautions	6
Conclusions	7
Appendix—Health Aspects of Non-Ferrous Foundry Processes	9
Pneumoconiosis in Non-ferrous Foundries	9
Metal Fume Fever (Zinc ague)	13
Lead Fumes	14
Other Metal Fumes	15
Other Fumes	17
Health Aspects of Fluxes, De-gassing, etc.	18
Carbon Dioxide Process	19
Shell Moulding	20
Diseases which, while not peculiar to non-ferrous foundry workers, might be influenced as to incidence by the foundry environment	21
Heat Exhaustion	22
First Aid including Treatment of Molten Metal Burns	23
References	24

INTRODUCTION

The First Report of the Joint Standing Committee on Safety, Health and Welfare Conditions in Non-Ferrous Foundries was published in 1957. It dealt with safety, health and welfare conditions in such foundries and the measures to be taken for dealing with them. It did not, however, deal specifically and in detail with the health aspects.

The Second Report which is now published sets out the views of the Joint Standing Committee on the Report of the Technical Sub-Committee which has considered existing and possible dangers to health in the non-ferrous founding industry. A note by Dr. W. D. Buchanan, H.M. Deputy Senior Medical Inspector of Factories, on the health aspects of non-ferrous foundry processes is included as an Appendix to the Sub-Committee's Report.

The general conclusions reached in the First Report are affirmed and the known health hazards in the industry are described together with indications of methods for overcoming them.

The Committee has thought it desirable to refer not only to known health risks, but also to potential risks in the materials used. The Committee considers that a knowledge of such hazards will result in the avoidance of risk which might otherwise be inadvertently introduced.

Second Report on Conditions in Non-Ferrous Foundries

Report of the Joint Standing Committee

To T. W. McCULLOUGH, Esq., O.B.E.

Her Majesty's Chief Inspector of Factories

1. The wide range of metals and alloys cast and the variety of methods used in the Non-Ferrous Founding Industry give rise to an equally wide range of environmental conditions. Questions of health therefore require careful consideration and whilst our First Report was not drafted without medical advice, we did not include at that stage of our discussions any sections specifically dealing with the health aspect of the matter. Health is, however, included in our terms of reference and so on the publication of the First Report we remitted this complicated matter to our Technical Sub-Committee.

2. Mr. A. Eyden, Mr. G. T. Hyslop and Dr. A. I. G. McLaughlin resigned from the Committee on the completion of the First Report, and we lost the services of Mr. Gavin Martin, who had given us much valuable assistance, when he retired from his position as General Secretary to the Confederation of Shipbuilding and Engineering Unions. Mr. Eyden and Mr. Hyslop also resigned from the Technical Sub-Committee and we are glad to be able to express our indebtedness to these two gentlemen for the very great assistance they gave us through the Sub-Committee. In consequence of their resignation we appointed Mr. A. Graham and Mr. E. Ayres to the Sub-Committee and when Dr. Buchanan had joined us the Sub-Committee co-opted him for the medical discussions. We are also indebted to Mr. W. A. Attwood, who was Secretary to the Committee until June 1958.

3. Our Technical Sub-Committee has now completed the Report on Health Aspects of Non-Ferrous Foundry Processes. We think that this Report warrants the close attention of the Industry and therefore submit it to you, with the recommendation that it be published as the Second Report of the Joint Standing Committee. The Report is entirely practical and deals with known risks. We are of the opinion that the Industry should act on this part as soon as possible. The Appendix is medical and covers both known and potential risks and we have no doubt that the Sub-Committee are right in suggesting that a good knowledge of this part would result in the avoidance of many risks which might otherwise be introduced inadvertently with new processes. Finally we agree with the Sub-Committee in their view that medical supervision is desirable wherever it can be arranged, and that a general medical survey of the Industry would help greatly by establishing the type and magnitude of the health risks involved.

H. WOODS (*Chairman*)

E. AYRES

H. G. BARRATT

JAMES H. BARWELL

W. D. BUCHANAN

F. BULLOCK

F. G. BURRELL

G. W. CHILTON

J. GARDNER

A. GRAHAM

L. W. GUMMER

C. W. HALLETT

P. B. HIGGINS

W. T. HOBKIRK

L. KEALEY

A. E. MILLS

C. E. WATSON

J. H. WIGGLESWORTH

F. W. WINSLADE

W. B. LAWRIE (*Secretary*)

TECHNICAL SUB-COMMITTEE

Mr. A. GRAHAM (*Chairman*)

Dr. W. D. BUCHANAN, B.Sc., M.B., Ch.B., D.P.H.

Mr. E. AYRES

Mr. J. GARDNER

Mr. J. H. WIGGLESWORTH, O.B.E.

Mr. W. B. LAWRIE, M.B.E., M.Sc., F.R.M.S., A.I.M.

Report of the Technical Sub-Committee

To H. WOODS, Esq. (*Chairman*)

*Joint Standing Committee on Safety, Health and Welfare Conditions in
Non-Ferrous Foundries*

1. One section of the First Report of the Joint Standing Committee on Safety, Health and Welfare Conditions in non-ferrous foundries*¹ was headed "Foundry Processes". Because of the complexity of the matter reference was made to other sections of the First Report and finally in paragraph 39 it was recommended "that each process be considered separately, that dust and fume control should be applied at source before general ventilation is considered and that where local control is impracticable it may be desirable to segregate the particular process so that it does not pollute the whole foundry".
2. In view of the suggestion that each process be examined separately, we have discussed the health hazards that might appear in the non-ferrous founding industry with Dr. W. D. Buchanan, who was co-opted to the sub-committee for the purpose, and these discussions have covered a wide range of non-ferrous processes.
3. We have, in this Report, made only general statements relating to the control of dust and fumes because we are concerned here only with principles. We appreciate, however, that the control of dust and fume may be a very difficult matter and, in fact, we are ourselves engaged in research and development work in certain specific cases.
4. We are indebted to Dr. Buchanan, who is the medical member of the Joint Standing Committee, for an account of the various health risks that have appeared or that might be expected to appear in non-ferrous foundries, and we have included this account as an Appendix to this Report. Years ago the main risk was the well-known brass founders' ague which resulted from exposure to zinc oxide fumes and it was against this risk that the Casting of Brass Regulations² were directed in 1908. Since those days the non-ferrous industry has changed considerably. A great variety of metals and alloys is now used, the metallurgical treatment of these metals and alloys may be a very complicated matter and melting and moulding practices have changed out of all recognition. In consequence, the health conditions have also changed.
5. The Appendix was drafted to include actual and possible risks so that possible risks might be anticipated and either avoided or counteracted as new processes or metals are introduced. We have already remarked that the health risks have changed since 1908. It should not be forgotten that they are changing with every new development and circumstance in the foundries and that they vary from metal to metal and process to process. Some of the risks described in the Appendix may apply to all non-ferrous foundries and some may apply to only a few foundries. The potential risks to which the Appendix refers should be considered in relation to every foundry process and close observation should be kept in those places where any of these potential hazards might ultimately

*¹ Hereinafter called the First Report.

produce specific illness. Immunity from industrial disease is only obtained by continual vigilance and we recommend that this Report be published because we think it will provide a medical basis for that vigilance.

GENERAL CONSIDERATIONS

6. We have examined the First Report in the light of the medical evidence and although we think that there is at present nothing to alter in and little to add to the recommendations in that First Report, we consider that certain matters warrant further comment.

7. There can be no doubt that the amount of dust and fume present in non-ferrous foundries should be kept to a minimum. This suggestion formed the basis of the First Report and we can do no more than emphasize it. We agree, too, with the First Report that dust and fumes should be eliminated if possible, controlled at source if elimination is not practicable, and dealt with by general ventilation only if local control is impracticable. In this latter case, it may also be desirable to segregate particular processes so that the whole foundry is not polluted. In this connection, we think we should make one or two general comments.

8. Dust produced by dressing processes can often be reduced by a careful attention to the sequence of operations. We think it important to stress the point that castings (other than die-castings) should not be given to dressers until they have been treated in some form of mechanical blasting equipment. The bulk of the dust will then have been removed during mechanical fettling, leaving on the casting a relatively small quantity which can be dealt with by one of the newly developed local exhaust ventilating systems. Wire brushing should never be done without local exhaust ventilation. The work may be done on dressing benches fitted with local exhaust ventilation or alternatively the low volume high velocity exhaust system may be fitted to wire brushes of any type.

9. Fumes often pollute the atmosphere of non-ferrous foundries and a good deal of work is in hand in an effort to control them. Here again, there are one or two comments we must make. In the first place, we have no doubt that temperatures of molten metal should be kept as low as possible. Large quantities of fume may be produced simply by adding alloying elements at excessive temperature, relatively large percentages of the alloys themselves being lost in the process. Fume is also given off from pots of metal standing in the foundry to cool to the correct temperature before they are cast. These pots have been overheated in the melting furnace, so wasting fuel and increasing the metal loss. They must then stand in the foundry where they produce a troublesome fume problem that could have been avoided if the metal had never been overheated in the first place.

Finally, some alloys fume as they are being cast. The smaller the distance that these fuming ladles have to be transported the better, so that one preliminary to the successful control of fumes may well be the setting of a limit to the travel of ladles of metal between furnace and casting. What is possible in this respect will vary from place to place, but clearly the ideal state occurs when the ladle need not be moved at all between melting furnace and casting point.

10. Some of the health hazards in the Appendix are well established and actual risks; these will have to be countered. Many of them, however, are potential risks inherent in the materials used. Often the effects of these risks have never been seen in foundries, and we think they never will be if founders who use the materials understand the risks and act accordingly. We are quite certain, however, that the information should be widely disseminated because good health depends so much on accurate knowledge. A few of the materials like beryllium are really dangerous. These may come more and more into foundry use as metals are changed, and we are anxious that foundry men should appreciate the risks and take all the necessary steps to avoid trouble before they introduce materials of this kind.

We think, therefore, that medical supervision is desirable and there is no doubt that wherever it can be arranged, many future difficulties may be avoided. We would also welcome a general medical survey of the industry in order to establish the kind and magnitude of the health risks involved.

DUST

Pneumoconiosis

11. It would appear from Tables A and B and the relevant medical comments (see pages 11 to 13) that there may be more pneumoconiosis in non-ferrous foundries than had been supposed in the past. This implication does not alter in any way the series of recommendations on the suppression of dust which were published in the First Report. All it means, is that there is a greater need to apply the recommendations throughout the industry.

FUMES

Metal Fume Fever (Zinc ague)

12. This illness is less common than it was, but it still occurs when yellow brasses are cast if the fumes are not controlled. It may also occur occasionally in alloys with a low zinc content (e.g., gun metal) if the casting temperature of the alloy is high. Clearly a good deal less zinc fume will be given off from an alloy cast at a lower temperature.

Lead Fumes

13. The casting of lead itself requires special precautions and it should not be forgotten that men employed in foundries casting leaded gun metal are exposed to some slight risk of lead absorption.

Beryllium

14. No case of beryllium poisoning has been known to have occurred in foundries in this country. It is known, however, that certain compounds of beryllium are toxic and both acute and chronic forms of poisoning are recognized. There appears to be no relationship between the extent of the exposure and the incidence, or severity, of the chronic type of the disease, and although the disease usually affects the lungs most severely, all organs may be affected to some degree. Wherever beryllium fumes are produced, there is a risk of poisoning and it has been tentatively suggested that levels above 2.0 micro-grammes per cubic meter of inhaled air give risk of chronic poisoning.

We do not wish to stress these figures unduly, but they mean for all practical purposes that beryllium fume must be completely suppressed.

We repeat that no case of poisoning has yet been known to have occurred in foundries in this country, but we must stress the necessity for the highest possible standard of control if beryllium is used, even if this means total enclosure.

Cadmium

15. The reddish fumes of cadmium oxide which are given off when alloys containing cadmium are cast are extremely irritating to the lungs and may cause severe damage and even death. There is also a chronic form of cadmium poisoning. These fumes should, therefore, be controlled and a very high standard of local exhaust ventilation is needed.

Phosphorus

16. The fumes emitted when phosphorus is added to molten metal include phosphorus pentoxide, which quickly forms a fog of phosphoric acid from the moisture in the atmosphere. Continued inhalation of phosphoric acid may well result in chronic bronchitis or other lung diseases and if yellow phosphorus is used very large quantities of fume may be produced. These fumes should be controlled.

Yellow phosphorus ignites spontaneously in air and if the skin is burned by spurts of the material, the affected area should be kept wet. A first aid treatment is to cover it with pads soaked in 2 per cent solution of copper sulphate and where yellow phosphorus is used, this solution should be kept available.

Selenium and Tellurium

17. These elements are not often used in foundries, but we are informed that tellurium has been used in small quantities in one iron foundry and we know of the existence of copper base alloys which contain it.

The elements themselves are considered to be relatively non-toxic, as are the selenides and tellurides of copper and other common non-ferrous metals, but both elements do give some highly toxic inorganic compounds. The most severe poisoning effects have not been found in non-ferrous foundry practice, but there has been some throat irritation and operators often develop an unpleasant garlicky odour to the breath. The metals should, therefore, be treated with some care and fumes from them should not be allowed to pollute the foundry atmosphere.

Chlorine

18. Chlorine is a severely irritating toxic gas which should obviously be controlled. We agree with the First Report that nitrogen de-gassing should be substituted wherever possible.

OTHER HEALTH PRECAUTIONS

Rheumatic Disorders

19. Very little information is available about these disorders at present, although much research work is in progress. So far as non-ferrous foundries are concerned the conditions which contribute to rheumatism should be removed as far as possible. This may be particularly significant in the building

of new foundries and it means generally that such things as abnormal working postures, violent exertion, rapid changes of temperature, extremes of temperature and damp and wet conditions are undesirable.

Heat Exhaustion

20. This matter is discussed in the Appendix where saline drinks are recommended if there is much exposure to heat. We agree, of course, with this recommendation, but we are certain that the best approach to the matter was indicated in the First Report. Much of the heat exposure comes from melting furnaces³ and it is self evident that higher fuel efficiency would result in less heat loss from the furnace and in consequence less heat exhaustion in the men. In the best conditions heat exhaustion is unknown.

CONCLUSIONS

21. This Report was drafted after we had examined, in discussions which covered a wide field, the health hazards which might appear in non-ferrous foundries. The Appendix includes both actual and potential health hazards. This was done deliberately to provide general guidance to the industry. Actual and present hazards should, of course, be dealt with, but we hope, too, that the medical opinion on potential hazards will be examined by all founders so that when processes or materials are changed, new risks will not be introduced inadvertently. Some of the effects of the potential risks may not have been heard of in foundries. We hope they never will be, and indeed we think they never will be if those who are responsible for new processes are sufficiently well informed. We have, therefore, endeavoured to supply some of the necessary information in the Appendix.

22. We have found little to add to the recommendations of the First Report, which have proved to be wide enough to cover all the facts at present known. In this Report, however, we have indicated those practical matters which seemed to us to require more immediate attention in view of the medical evidence. We have done no more than indicate general principles in this document, because different foundries may well use different methods to attain similar ends in an industry as diverse as non-ferrous founding. We are still engaged in discussions, and on research and development work, in the hope of finding specific solutions to particular problems. We shall give our results to the Industry as they accrue, but in the meantime we recommend that this Report be published in the hope that all non-ferrous foundry men will meet the principles suggested in this section for known and actual risks and acquaint themselves with the Appendix so that new diseases will not be brought into the Industry with new materials or new methods.

A. GRAHAM (*Chairman*)
W. D. BUCHANAN
E. AYRES
J. GARDNER
J. H. WIGGLESWORTH
W. B. LAWRIE

APPENDIX

HEALTH ASPECTS OF NON-FERROUS FOUNDRY PROCESSES

(Note prepared by Dr. Buchanan for consideration by the Sub-Committee)

Non-ferrous foundries, as exemplified by the older type foundry casting yellow brass, have long been regarded as unhealthy places in which to work. In the past, however, attention was largely directed to the considerable exposure to nascent zinc oxide fumes with their typical symptoms of ague, and this preoccupation with this obvious effect of working in such foundries resulted in the Casting of Brass Regulations of 1908.

Ague from zinc fumes is no longer the outstanding feature of work in non-ferrous foundries and, on the other hand, the introduction of new alloys and new metals with developments in technology have brought about an entirely new group of health risks, the extent of many of which remains to be evaluated. There is a growing weight of evidence too, that pneumoconiosis, which has usually been regarded as of relatively minor significance in such foundries, is more prevalent than is commonly realized.

The ensuing account presents the various risks, mainly specific, although some opinions are expressed on certain non-specific or general environmental ones, as they appear to the Medical Branch of H.M. Factory Inspectorate.

PNEUMOCONIOSIS IN NON-FERROUS FOUNDRIES

In contrast with the numerous papers dealing with pneumoconiosis (silicosis and mixed dust fibrosis) in iron and steel foundries⁴ there have been but few references to cases of pneumoconiosis in non-ferrous foundries. This may not appear so remarkable when it is considered that intensive studies of the health of foundry workers as a whole have only begun since 1931, since when, up to 1950, more than twenty-five radiographic and/or clinical surveys of various groups have been made. These studies have been carried out in thirteen different countries and revealed the presence of silicosis and other types of pneumoconiosis in all these countries among iron and steel foundry workers. While in some of these surveys non-ferrous foundry workers were included, as a rule they have not been sharply differentiated.

As a result of this lack of positive evidence pointing to pneumoconiosis in non-ferrous foundry workers it has been generally assumed that the risk in these foundries is either low, or non-existent. However, in a Paper published in 1955, McLaughlin and Harding gave the working histories and pathological details of the lungs of six men who had spent, virtually, all their working life in non-ferrous foundries,⁵ mainly brass, and who were found to have varying degrees of fibrosis at autopsy. Four of these men were brass moulders and casters and two were fettlers. Fibrosis was considered to be a clear cause of death in two of them, doubtfully so in two others and

an insignificant factor in the remaining two. Only ten deaths from silicosis (with or without tuberculosis) in non-ferrous foundry workers had at that time come to the notice of H.M. Factory Inspectorate since 1936.

There are several reasons why pulmonary fibrosis might be expected to have a lower incidence in non-ferrous foundries as compared with iron and steel foundries. The sand used is less siliceous, the temperature of the metal as it is cast is much lower and as a consequence the sand separates from the casting more easily and less fettling is required. Vigorous wire brushing is one of the most important sources of dust production in the open foundry.

An important source of free silica exposure common to all types of foundry has been eliminated in the prohibition of the use of siliceous parting powders in 1950 and cases now coming to light may have had a significant exposure before that date.

A large-scale clinical and radiological investigation into the health of non-ferrous foundry workers along similar lines to that employed by McLaughlin and his team in the case of iron and steel foundry workers would go a long way to settling this problem. Meanwhile, for several years the Medical Branch of H.M. Factory Inspectorate has been investigating the working histories of all men who have successfully claimed for industrial injuries benefit under the various pneumoconiosis schemes.

In the period from 1953 to 1956 inclusive, at least twenty-seven claimants for pneumoconiosis medical benefit, whose sole or significant employment has been in non-ferrous foundries, have been accepted by the Ministry of Pensions and National Insurance for compensation. These men, two of whom died soon afterwards, had a mean age of 54 years, extremes ranging from 31 years to 76 years and a mean dust exposure (entirely or significantly in non-ferrous foundries) of 34 years. Twenty-four were moulders or moulders and casters and three metal dressers.

Of special interest in the "moulder" group is the inclusion of four men who were engaged mainly or entirely in moulding for aluminium castings. To some extent the term "moulder", as used here, is a composite one. A significant number, as might be expected, also worked as metal melters and pourers or occasional core makers. Complete evidence on the nature of parting powders used might throw further light on to these cases but it was not available.

Deaths in non-ferrous foundry workers, in which pneumoconiosis was recorded as a cause, known to H.M. Factory Inspectorate in the period from 1945 to 1956 have numbered fourteen. With this group it has sometimes been possible to obtain a more detailed and consequently more accurate working history, including exposure to siliceous parting powders. In this group the average age at death was 55 years and the average exposure to dust 32 years. Table B below sets out the detailed information which is based on inquest proceedings and returns from the Registrar-General.

These records do not give any information on the incidence of pneumoconiosis in non-ferrous foundries related to the total population at risk nor can they be used comparatively with those derived from iron and steel foundries. They do, however, indicate that pneumoconiosis, even severe enough to cause disablement or death, does occur in non-ferrous foundries. To what extent they are influenced by past conditions, e.g. the use of siliceous parting powders, it is difficult to say. These undoubtedly played a role as is seen from some of the working histories of fatal cases but do not seem to have accounted for all the cases. Only a survey of the industry is likely to give a true picture of the relative incidence.

Table A gives details of twenty-seven cases of pneumoconiosis occurring in non-ferrous foundry workers for the period 1953 to 1956 and accepted for industrial injuries benefit by the Pneumoconiosis Medical Panels. It should be pointed out that non-ferrous foundry work was brought into the category of prescribed occupations only in 1954 [National Insurance (Industrial Injuries) (Prescribed Diseases) Amendment Regulations, 1954 (S.I. No. 5)], but castings cleaners in all foundries who used power-driven tools were entitled to apply for benefit from 1950 [National Insurance (Industrial Injuries) (Prescribed Diseases) Amendment Regulations, 1950 (S.I. No. 1565)].

Table B shows the number of recorded deaths from pneumoconiosis in non-ferrous foundry workers in the period 1945 to 1956. These are based on inquest proceedings and returns from the Registrar-General. It will be seen that there are fourteen such cases.

The information given in these Tables illustrates the fact that a health risk in an industry may be hidden until a specific inquiry is made. Once the disease is recognised other cases soon come to light.

TABLE A

Non-ferrous foundry workers accepted for Industrial Injuries benefit by the Pneumoconiosis Medical Panels in the period 1953-1956 inclusive

Serial	Age	Employment	Period of Dust Exposure	Assessment of Disability
1	55	Metal dresser	19 years	100%
2	76	Fettler mostly	45 years	100%
3	42	Metal dresser	25 years	20%
4	50	Brass moulder and caster ..	36 years	100%
5	59	Brass caster and moulder ..	41 years	70%
6	52	Brass moulder	33½ years	100%
7	52	Brass caster and moulder ..	34 years	80%
8	32	Brass moulder	18 years	20%
9	54	Brass moulder } Filler .. }	28 years 1½ years	40%
10	58	Brass moulder (iron moulding 6 years)	37 years	100%
11	48	Brass moulder	29 years	20%
12	58	Iron moulder .. } .. Steel moulder .. } .. Aluminium moulder } ..	4 years 4 years 35 years	50%
13	59	Aluminium moulder	42 years	100%
14	31	Moulder (various non-ferrous metals)	17 years	5%
15	65	Brass foundry moulder	43 years	10%
16	51	Iron moulder .. } .. Aluminium moulder } ..	3 years 35 years	100%

Serial	Age	Employment	Period of Dust Exposure	Assessment of Disability
17	53	Brass moulder	32 years	30%
18	49	Caster and moulder (brass and nickel)	34 years	5%
19	65	Moulder and caster	51 years	20%
20	55	Moulder and grinder (synthetic wheel)	36 years	100%
21	60	Brass and gun metal moulding ..	44½ years	10%
22	52	Non-ferrous moulding (including aluminium)	36 years	100%
23	52	Aluminium moulder (talc exposure)	38 years	30%
24	66	Brass moulder	40 years	20%
25	53	Brass moulder, core maker and fettler	38 years	20%
26	62	Non-ferrous moulding	35 years	50%
27	55	Brass melter, moulder, some fettling	34 years	50%

It is noted that where a person is found to be suffering from pneumoconiosis accompanied by tuberculosis, the effects of the tuberculosis shall be treated for compensation purposes as if they were the effects of the pneumoconiosis. Both conditions were present in several of the above workers awarded a 100% disability assessment.

TABLE B

*Non-ferrous Foundry Workers
Death Certificates recording Pneumoconiosis in the period 1945-1956*

Serial	Age	Employment	Dust Exposure	Remarks
1	60	Brass moulder	29 years	Silica brick—furnace ashes crushed for many years to produce parting powder.
2	51	Brass caster	31 years	Silica-free parting powder for at least 20 years.

Serial	Age	Employment	Dust Exposure	Remarks
3	54	Brass moulder and caster	25 years	Non-siliceous parting powder for last 10 years.
4	54	Brass turner and aluminium alloy turning	30 years	Small amount of sand probably adhered to internal parts of castings
5	58	Brass caster's assistant ..	36 years	Crushed firebrick used as parting powder prior to 1924, thereafter non-siliceous parting powders
6	57	Moulder in non-ferrous foundry Foreman in non-ferrous foundry	36 years 6 years	Used ground-up red sand as parting powders
7	53	Brass caster	30 years	Silica free parting powder last 20 years
8	52	Aluminium foundry moulder	20 years	Silica free parting powders used latterly
9	57	Non-ferrous caster ..	34 years	—
10	52	Brass moulder and caster	37 years	Silica parting powder suspected
11	50	Brass moulder	36 years	32 years self-employed
12	59	Brass moulder mainly (iron foundry moulder 2 years)	38 years	—
13	59	Aluminium moulder ..	27 years	—
14	57	Bronze fettler	35 years	—

METAL FUME FEVER (ZINC AGUE)

This condition as it occurs in brass foundries is the classical occupational illness of this industry and inspired the Casting of Brass Regulations, 1908. Although other metal fumes can give rise to a similar syndrome of pyrexia, drenching perspiration and shivering, zinc is the metal responsible in the casting of alloys containing this metal. There appears to be no doubt that, although the condition is still encountered in the casting of the zinc rich yellow brasses, it is less common than formerly. Improved ventilation in casting almost certainly reduces the incidence of the condition.

Metal fume fever appears to be rare in the casting of the various gunmetals containing a relatively low zinc content of the order of 5 per cent. These have melting points

around 1,000°C. There is evidence, however, that metal fume fever may occasionally be encountered in high melting point alloys, even although the zinc content is very low.

LEAD FUMES

The risk of developing symptoms of lead poisoning from the inhalation of fumes from molten lead or from alloys consisting in the main of lead is well known.

The extensive use of leaded gunmetals, of which that corresponding to the formula 85 per cent copper and 5 per cent each of zinc, tin and lead is one of the best known, raises the question, however, whether, and if so to what extent, lead poisoning or evidence of lead absorption not amounting to frank intoxication, occurs with the use of low lead content alloys.

The paucity of instances of such lead poisoning reported under the Factories Act indicates that it is unusual, if not rare. In recent years, however, accounts of cases have been recorded in Reports of the Chief Inspector of Factories as follows:

(a) *Annual Report for 1952:*

Two cases of lead poisoning were reported, each employed for about 2 years in a fettling department, attached to a foundry in which alloys containing 5 to 20 per cent lead were made. One man worked on day shift at an abrasive wheel connected to an exhaust fan by ducting, the other similarly on night shift.

(b) *Annual Report for 1953:*

Three foundrymen employed on alternate weeks in the manufacture of lead copper bearings (30 per cent lead) were reported as suffering from a moderate degree of lead poisoning. Conditions in the foundry were good, and it was thought that core sands from repeated re-use might have built up lead which would become airborne as dust.

(c) *Annual Report for 1954:*

A furnaceman employed 20 years in a brass foundry suffered from lead poisoning with loss of appetite and energy, abdominal colic, weakness of the right hand and anaemia. He gave a history of earlier attacks in 1952 and 1953.

Another case, a caster for 14 months in two spells in a copper lead foundry suffered from colic, constipation, headache and on examination, was found to be anaemic.

Moreover, there are significant reports in the world literature, mainly from the United States of America. In one such Report⁶ covering four non-ferrous foundries, the lead level attained 0.8 mgm. per cubic metre during melting and 0.23 mgm. during pouring (the threshold for atmospheric lead is generally accepted as 0.15 mgm. per cubic metre). In the other three foundries, levels did not exceed the threshold. Of ninety-four foundry men examined, 11 per cent showed excessive lead absorption, as judged by stippled blood cell count and 34 per cent as judged by urinary lead excretion. Blood samples from twenty-four men with evidence of excessive absorption confirmed this in nineteen of the cases. Clinical examination discovered histories and symptoms suggesting that a mild alimentary type of lead poisoning might exist in many non-ferrous foundrymen. The lead content of the alloys cast varied from 4 per cent to 10 per cent.

In another paper of some significance⁷ observations on 219 men employed in a brass foundry, spread over a period of 2 years are reported. The products founded contained from 5 per cent to 15 per cent of lead. Ventilation was faulty. An acute outbreak of lead poisoning affected 23 men in the space of three weeks. All told, 37 men were seen with clinical lead poisoning.

It is clear from reported cases in this country and findings elsewhere that lead poisoning is a possibility in the founding of leaded gunmetal. No published accounts of formal investigations have been made in this country and in an attempt to determine the extent to which lead absorption occurs under average working conditions, four foundries were recently visited, and approximately 50 foundrymen examined by Dr. Browning and Dr. Rainsford, H.M. Medical Inspectors of Factories. These foundries were selected to give a reasonable cross-section of size and mixed environmental conditions. To act as a control to the series, 25 men were examined in an aluminium foundry employing both sand and die-casting methods.

The gunmetal foundries ranged in size from one employing seven to one employing approximately one hundred and twenty men. Although various non-ferrous alloys were cast in each, a significant quantity of leaded gunmetal mostly that corresponding to B.S. 1400/LG.2-C was also cast, ranging in quantity from 10 cwt to about 6 tons daily. One of the foundries had four fixed pouring periods per day, whilst others poured as required, often at more frequent intervals.

By comparing the blood picture of these men with, on the one hand, a series of lead workers, and on the other, the control group of aluminium casters, evidence of slight lead absorption was demonstrated. Both punctate and reticulocyte cell counts were slightly higher than in the control group, but considerably lower than those of workers in conditions where the lead hazard has been shown to be high. (The punctate cell count is commonly taken as an index of lead exposure and the reticulocyte count as an index of the rate of blood regeneration, e.g. following a toxic anaemia due to lead.) Examined by transmitted light in only one case in the group of fifty was the punctate cell count 2,000 per million normal cells (the level at which clinical examination is desirable) and in seven it ranged between 1,000 and 2,000 per million red cells. These eight men included one sand labourer, four furnacemen, one moulder, one core maker and one fettler. No significant degree of anaemia was found in any of these men.

The conclusion to be drawn from this study is that in the conditions of the investigation, workers in brass foundries casting leaded gunmetal are exposed to some slight risk of lead absorption.

OTHER METAL FUMES

To review fully the reported effects of all non-ferrous metals would be lengthy and serve little useful purpose, as in many cases their use is extremely specialized and limited. A brief account is given of the effects of the more important non-ferrous metals and metalloids.

Beryllium

Certain compounds of beryllium are toxic and both acute and chronic forms of poisoning are recognized. The acute variety takes the form of a chemical pneumonitis which may result in a lengthy illness before recovery. It has been recorded mainly in the recovery of the metal from its ores, but also in the casting of master alloy of copper and beryllium. To prevent the incidence of this acute disease a considerably higher standard of fume and dust control is required than that acceptable with the common toxic dusts and fumes.

The chronic form of the disease was first recognised over ten years ago in connection with the manufacture of fluorescent lamp phosphors. It presents several unusual features, the most notable of which is perhaps that there is no obvious relationship between the extent of exposure and the incidence or severity of the disease in those affected. It is now thought that the disease results when the tissues become sensitized to beryllium ion or oxide (most cases appear to be associated with exposure to the dust or fume of the oxide) and although the main brunt is usually on the lungs, it is looked on as a generalised disease, all organs being affected to some degree.

A series of cases¹⁰ of both acute and chronic varieties of the poisoning has been reported in the manufacture of copper beryllium master alloy from the United States of America, and although no foundry cases have been recorded in this country, one or possibly two cases from the cold working of copper beryllium sheet are known to have occurred.¹¹ A risk wherever beryllium fumes or dust are produced must be accepted.

Cadmium

The reddish fumes of cadmium oxide given off when cadmium alloys are cast are extremely irritating to the lungs and can readily and quickly bring about severe and even fatal pulmonary oedema.

There is in addition a chronic variety of cadmium poisoning of great importance. The possibility of chronic poisoning was suggested in 1947 and in 1950 the first cases showing the now accepted typical syndrome of emphysema of the lungs and the presence of an unusual type of protein in the urine with the evidence of renal damage were described.

The first fatal cases of emphysema recognised in this country were described⁸ in 1954 comprising two men, members of a group of some twenty, making copper cadmium alloys. The suspected process was the addition of small quantities of cadmium (melting point 321°C, boiling point 767°C) to molten copper (melting point 1,083°C).

A detailed investigation⁹ made at two factories manufacturing copper cadmium master alloy and low cadmium alloy and reported in 1955 showed that of 100 men examined nine had emphysema and proteinuria, three emphysema alone and seven proteinuria without emphysema. In addition four men at one of the factories had been forced to give up work on account of disabling shortness of breath and one had died subsequent to the investigation. Pathological studies suggest that the emphysema found in these cases is different from that arising as a result of chronic bronchitis, although chronic bronchitis may arise as a complication in men with lungs so damaged.

The existence of a chronic form of cadmium poisoning can be taken to be authenticated and it has been added to the list of Prescribed Diseases for which Industrial Injuries Benefit is payable.

Magnesium

Magnesium on burning produces a dense white fume of the oxide which may be inhaled in appreciable quantities. Magnesia, of course, is non-toxic on ingestion and is consumed in considerable quantities in medical preparations. It does not automatically ensue that it is without effect on the lungs when inhaled. There is as yet, however, no clear evidence that the fume is harmful, nor does it appear in foundry practice to induce a metal fume fever. The relative solubility of the oxide suggests that the onset of fibrosis of the lungs would be unlikely.

Phosphorus

Phosphor copper may be used to de-oxidise copper and its alloys and phosphorus is of importance as an ingredient of certain bronze alloys. It is normally handled as a master alloy with copper, in which form there is no risk of phosphorus poisoning. The fumes emitted when added to a molten charge of metal include phosphorus pentoxide which quickly forms a fog of phosphoric acid. Repeated inhalation of a mist of phosphoric acid in common with other inorganic acids may well result in the development of chronic bronchitis and other lung diseases.

Phosphorus poisoning (a notifiable disease under Section 66 of the Factories Act, 1937) need not be feared from this use of phosphorus compounds. Occasionally, however, yellow phosphorus, which is highly poisonous, is added direct in stick form. A considerably greater amount of phosphorus pentoxide fume is then evolved. Yellow phosphorus ignites spontaneously in contact with air and should skin burns

result from splashing with spurts of molten phosphorus, the affected area must be kept wet. A first-aid treatment prior to dispatch to hospital is to cover the area with pads soaked in a 2 per cent solution of copper sulphate, which forms an inert compound with the phosphorus. Where it is essential to use yellow phosphorus, such a solution should always be kept available.

Selenium and Tellurium

Because of their chemical similarities these substances are considered together. Small amounts of selenium may be added to copper or copper alloys as the selenide, and tellurium may be added in small quantity to copper to increase machinability or with other non-ferrous metals such as lead, tin and magnesium.

Both elements yield highly toxic inorganic compounds. The elements themselves are regarded as being relatively non-toxic, as are the selenides and tellurides of copper and other common non-ferrous metals. Nevertheless, even supposedly non-toxic compounds of these two elements should be handled with care.

In foundry practice harmful exposure is most likely to result from fumes caused by the oxidation of tellurium. These have been recorded as causing nasal and throat irritation and the early development of an unpleasant garlicky odour to the breath and the sweat and other body secretions. This odour may be the first indication of exposure.

The more severe systemic poisoning effects do not appear to be recorded from non-ferrous foundry practice.

Vanadium

Although the great bulk of vanadium compounds is used in the steel industry, a small amount which may increase in the future is used as an alloying agent with copper and aluminium.

Since the war numerous medical papers have been published drawing attention to toxicity of certain vanadium compounds, including the pentoxide which is likely to result from oxidation of vanadium alloys. The main brunt has been on the respiratory system and both acute illnesses and more chronic effects, such as chronic bronchitis and emphysema, are recorded. Such reported outbreaks of poisoning have so far been restricted to contact with vanadium ores and to cleaning the tubes of oil-fired steam-raising boilers or heat exchangers. Certain oil fuels contain an appreciable vanadium content in their ash. No cases of vanadium poisoning are known following the use of mineral oils in foundries and they are not anticipated.

OTHER FUMES

Examples of fumes from core oils and binders, drying stoves, mould drying and furnaces have been considered by the Committee in their First Report.

The effects of exposure to sulphur dioxide in magnesium foundries are considered in discussing chronic bronchitis in non-ferrous foundry workers and fumes associated with shell moulding, the carbon dioxide process and the use of various fluxes and degassing agents in their respective Sections.

Magnesium castings may be etched in boiling sodium bichromate solution generally of about 4 per cent concentration. The bichromates are a potent cause of dermatitis and in addition may readily induce ulceration of the skin or the septum of the nose which, in the latter site, may go on to actual perforation. This ulceration is a reportable condition under the Factories Act. Although usually associated with an electrolytic process such as plating or anodizing, ulceration in chromating processes, especially hot processes, has been reported on a number of occasions and recent accounts of outbreaks are to be found in the Annual Reports of the Chief Inspector of Factories for the years 1954 and 1955.

Mineral Oil Fumes

These are encountered in a variety of processes, e.g. while used as a fuel in portable mould dryers or for ladle drying; as a lubricant in die-casting; as an ingredient in core oils. The possible effects on health will vary according to the use to which the oil is put. Pyrolysis (burning) under conditions of deficient air supply may result in production of carbon monoxide; more complex products of combustion may have a long-term carcinogenic action. Fumes from combustion of diesel oil are popularly associated with this risk, although the evidence to support it is at present inconclusive. Inhalation of oil fume produced in die-casting may entail special risks discussed later.

Welding Fumes

Although not an integral part of non-ferrous foundry practice, electric arc welding may be done as an ancillary or subsequent process. In such circumstances there may be exposure to the fumes of the electrode coatings from the electrodes themselves or from coatings on the metal being welded. The effects on the health of welders from such exposures has been investigated in some detail by Doig and Duguid²⁸. Additional information on the subject is to be found in the booklet "Health and Safety in Welding", recently (1956) published by the Institute of Welding²⁹.

In the welding of non-ferrous metals, inert gas shielded electrodes are frequently used. It is claimed that in this technique there is a measurable production of ozone and the toxic oxides of nitrogen with harmful effects on the respiratory system and due to greater current densities a marked increase in the production of ultra-violet light. There is thus a greater need for adequate fume control and eyeflash injuries are more likely to arise²⁹.

HEALTH ASPECTS OF FLUXES, DE-GASSING, ETC.

Despite the extensive use of a variety of fluxing and de-gassing agents in the non-ferrous founding industry, detailed knowledge of levels of atmospheric pollution, the nature of breakdown products and their concentrations in the foundry atmosphere, with their effects on the health of employees, is lacking. At the present time there is no evidence pointing to serious damage to health, while that suggesting minor ill-effects is inconclusive. Before complacency is justified, however, there is need for detailed medical enquiry, since many of the compounds are in themselves toxic agents or capable under the conditions of use of becoming toxic.

Of the many materials in use interest from a health aspect centres mainly on the use of chlorine and hexachlorethane as de-gassing agents in aluminium foundry practice, the various compounds of fluorine used as fluxes and to a less extent the use of manganese dioxide to obtain oxidizing conditions in copper zinc alloys. Mention must also be made here of the extensive use of sulphur to produce an inert atmosphere in magnesium casting; the problems from production of sulphur dioxide are considered later. Unfortunately the proprietary nature of so many fluxes and de-gassing compounds makes it impossible to comment in detail on individual preparations.

Chlorine De-gassing

The severe irritant and toxic effects of chlorine gas particularly on the respiratory system in general and the lungs in particular are so well known as to make discussion here unnecessary. The Committee has expressed the view that wherever possible nitrogen should be substituted.

Hexachlorethane

This compound, a solid, is the usual means employed for de-gassing aluminium and is generally added as a proprietary preparation. It may be used in conjunction with fluorine preparations. Hexachlorethane itself should not be confused with the

liquid tetrachlorethane which is regarded as the most toxic of all the organic solvents, so much so indeed, that it is now rarely used in industry.

The changes taking place when hexachlorethane is added to a charge of molten aluminium are complex and imperfectly understood. The main component of the dense fume emitted is thought to be aluminium chloride. While no records of ill-effects from exposure to this fume appear to exist aluminium chloride is an irritant substance and fumes should be suppressed to avoid the possibility of symptoms of lung irritation.

Fluxes containing Fluorides

Compounds of fluorine which produce fluorine ions are toxic with both acute and chronic effects. Acute effects are uncommon in industrial practice (apart from accidents from exposure to hydrofluoric acid gas and skin burns from that acid and the more soluble bifluorides).

Chronic effects in adults chiefly manifest themselves by alteration in the structure of the skeleton with a tendency to ossification of ligaments and tendons. There may be encroachment on normal blood-forming marrow tissue with severe anaemia. Renal damage is a further possibility.

The first industrial cases of chronic fluorine poisoning in this country were reported by the Chief Inspector of Factories in his Annual Report for 1941. They did not occur in the non-ferrous founding industry. In 1949, the Medical Research Council published the results of a special investigation into the problem of fluorine fumes in aluminium smelting. This investigation¹² failed to find any disabling symptoms in workers in the factory concerned, although a few showed X-ray changes in their bones consistent with skeletal fluorosis.

Fluxes containing borofluorides or silicofluorides yield, on contact with the molten metal, the toxic gases boron trifluoride and silicon tetrafluoride.

In an environmental and clinical study¹⁴ of the risk of fluorosis in magnesium foundries published in 1947, the fluorine content of atmospheric dust ranged from 0.143 mgm. to 6.37 mgm. per cubic metre (the current United States threshold level is 2.5 mgm. per cubic metre). Of 124 persons examined, only one was found to have radiological signs suggestive of fluorosis, but only 47 of the workers had been exposed to risk for as long as six years.

There was an increased urinary excretion of fluoride when compared with a controlled group, but no increased blood level.

Although the reported instances of chronic fluorine poisoning have arisen in conditions where exposure may be more severe than is likely to arise in average foundry conditions, they indicate that care is necessary in handling fluoride containing fluxes with elimination of dust or fume or the maximum possible control.

Manganese Fluxes

Fluxes containing manganese dioxide ore (pyrolusite) may be employed to produce oxidizing conditions in melting copper zinc alloys. Manganese dioxide gives rise to a chronic form of poisoning which affects the nervous system, but cases are very rare and none is known to have occurred in foundry practice.

Sulphur in Magnesium Casting

This has been considered elsewhere in relation to exposure to sulphur dioxide. It seems appropriate in this section to mention that elemental sulphur itself can be an irritant to the eyes and upper respiratory passages where there is exposure to fine dust as in the extensive dusting operations using flowers of sulphur.

THE CARBON DIOXIDE PROCESS

The matters of possible health significance in this process are:

- (a) The use of organic inflammable solvents as vehicles for plumbago in the coating of moulds and cores.

- (b) The formation of appreciable amounts of soda ash and synthetic silica of small particle size as a result of the reaction between the sodium silicate and carbon dioxide.
- (c) Frost-bite if carbon dioxide gas is allowed to escape from gas lines under pressure with such speed that objects in contact become markedly cooled down.

As regards (a) the solvents usually encountered are industrial methylated spirit and isopropanol. The former contains about 5 per cent methyl alcohol. This alcohol when drunk has caused many cases of blindness. The evidence pointing to a similar effect from its industrial use is conflicting, but it may be accepted that where methylated spirit is used in conditions of reasonable ventilation, no risk from such an effect is likely.

Isopropanol has had a shorter period of usage as an industrial solvent. No case of industrial poisoning following its use has been recorded, although among mould sprayers using this alcohol, while a majority have not complained of any irritation by the fumes, one or two cases have been recorded in which there were complaints of some irritation of the eyes, nose or upper lung passages.

With reference to (b) treated sand after casting has been found to contain small amounts of sodium carbonate. Sodium carbonate is an irritating dust, although the amounts present should not normally cause trouble. One group of castings dressers complained of nose and throat irritation and partial loss of voice.

No definite opinion is possible as yet on the hazards arising from dust from this technique. Dust counts would provide valuable information on this process.

SHELL MOULDING

Four matters of actual or potential health interest in this process are:

- (1) The effects of prolonged exposure to the very fine silica sand used.
- (2) The effects from inhaling the resin dust which is in an extreme form of sub-division.
- (3) Fumes arising from spraying the pattern plate and from shells after casting, and
- (4) Dermatitis.

Insufficient time has as yet elapsed since this process was introduced to expect to find any clinical or radiological evidence of pneumoconiosis from exposure to the fine silica sand. Dust count estimations at the present stage will determine whether conditions potentially capable of causing pneumoconiosis do in fact exist.

No ill-effects in human beings from the inhaling of fine dispersions of synthetic resin dust have been reported, but it may be of some significance that under experimental conditions, disease of the lungs has been produced in animals. The condition to which the title "Resinosis" has been applied is thought to be a simple physical blockage of the finer air passages and alveoli.

Fumes from pattern plate spraying in which a silicone suspended in a medium is normally used will depend on the nature of the suspending medium. In one observed instance where carbon tetrachloride had been adopted because of the absence of a fire risk, the sprayer developed symptoms corresponding to chronic bronchitis. In theory the hot pattern plate was capable of converting carbon tetrachloride in part into phosgene, which may have been a factor here. No phosgene in air levels were determined.

Dermatitis is the most probable specific ill-effect one may expect in this process. Several factors possibly potentiating one another are responsible:

- (1) Contact with uncured resin powder. The usual resin, phenol formaldehyde, in this state is a known skin sensitizer and irritant. Hexamine commonly included as an accelerator is an additional sensitizer.

(2) Friction from the fine sand in use.

(3) Heat from the curing stoves, etc.

Factors (2) and (3) may aggravate each other by causing sweating and maceration of the gloved hands.

Airborne dust may cause irritation and dermatitis of the face and neck regions. There appears to be less dust with the use of precoated sand.

Enquiries made by various Medical Inspectors at foundries employing shell moulding have indicated that the occurrence of dermatitis in the absence of stringent precautions is common.

DISEASES WHICH, WHILE NOT PECULIAR TO NON-FERROUS FOUNDRY WORKERS, MIGHT BE INFLUENCED AS TO INCIDENCE BY THE FOUNDRY ENVIRONMENT

Rheumatic Disorders

There is, at the present time, a good deal of re-thinking on the real cause of many conditions formerly grouped together as the rheumatic diseases. There is no evidence to support the idea, nor is there reason to expect that acute articular rheumatism and rheumatoid arthritis are in any way associated with occupation. Sciatica and lumbago are now believed to be associated with disc lesions of the vertebral column with pressure effects on the spinal cord. In these, heavy lifting or strains might bring about strains in the inter-vertebral joints. Osteo-arthritis is a degenerative condition of a joint or joints, and, while the condition is very common in older people, it does occur in the younger age groups when repeated straining is an important factor. Neuritis, e.g., brachial neuritis is generally capable of explanation under a mechanical causation. The important and possibly most disabling "rheumatic" condition remaining is fibrositis. Fibrositis is of particular importance in terms of man hours of lost work: it is of much less importance in terms of individual total disablement.

Among the occupational factors generally accepted as major contributors to "rheumatism" are abnormal working postures; violent exertion; the over use of certain muscles and joints; and rapid changes of extremes of temperature, damp and wet. These conditions, or several of them, are of course present in average non-ferrous foundries. Because of the loose fashion in which the term "rheumatism" has been used by both medical and lay persons, it is not possible to make any dogmatic assertions of the true and relative incidence of "rheumatism" in this industry. A carefully worked out medico-statistical enquiry might be one means of determining this important matter and the investigations being undertaken by the Empire Rheumatism Council may provide some indication.

Chronic Bronchitis

Similar difficulties arise in the ascribing of individual cases of chronic bronchitis to an occupational cause. As with rheumatic disorders there are conditions present in non-ferrous foundries which are usually regarded as promoting chronic bronchitis or of aggravating already existent disease.

A number of these factors is connected with the processes and have been alluded to elsewhere. Of these the considerable exposure to fumes of sulphur dioxide in magnesium casting is possibly of special significance. Sulphur dioxide is a respiratory irritant but much less is known of the effects from inhaling low concentrations over lengthy periods. Sulphur dioxide is believed to constitute the nucleus of "smog" particles which have caused so many deaths from respiratory disease among older members of the civilian population.

It is not possible to state unequivocally that there is a higher than normal incidence of chronic bronchitis in magnesium foundry workers, but a wise precaution would be to avoid employing for the first time workers with chronic bronchitis in this industry.

It is understood that an investigation has been recently commenced at one large magnesium foundry to determine whether there is a significant statistical difference in the incidence of chronic bronchitis when compared with a control group. This investigation may shed considerable light on this difficult problem.

Cancer

For practical purposes, we think in terms of cancer affecting the skin and the lung or bronchi. It is true that there are other sites for occupational cancer, but they are restricted to highly specialised non-foundry processes.

Occupational skin cancer is particularly associated with contact over many years with mineral oil, coal tar or pitch. Where any of these compounds is in regular use, skin cancer is a possibility even if a slight one. The risk in non-ferrous foundries is probably of a low degree.

Lung cancer presents a more difficult problem. The growing incidence in the past decade or two has directed much inquiry to this distressing condition and many substances have come under suspicion sometimes, on the most meagre evidence. This is, in general, the case with the various fumes and dusts encountered in non-ferrous foundries. Fumes from core stoves and mould dryers, if used, come into this category, as do possibly the fumes from pit fires. Some interest also attaches to oil fumes produced at pressure die-casting machines which may emit much fume each time the die is lubricated.

Much additional work will be required before any unequivocal answer is possible. A survey has been undertaken by Dr. McLaughlin and Dr. Cottrell, H.M. Medical Inspectors of Factories, into the possible ill-effects from exposure to oil mists and fumes, but no firm conclusions can be drawn from the results. It is, however, worthy of note that Dr. McLaughlin, in an analysis of deaths in steel foundrymen¹⁹, has noted an apparently high incidence of lung cancer without attempting to draw any conclusion from the observation. It is possible, assuming the existence of a noxious factor, that it is one common to all types of foundry.

Epidermophytosis

Epidermophytosis of the feet ("Athlete's Foot") is known to have presented itself as a problem in certain factories where showers are well patronised. The fungus spreads by contagion and it is accepted that floors of bath houses must be kept clean. This problem may be expected in non-ferrous foundries and, in general, the larger the unit the more likely is epidermophytosis to appear.

HEAT EXHAUSTION

The body temperature is maintained at or about 98.4°F by a variety of processes. In conditions where the ambient temperature is high or there is a great deal of radiant heat¹³, heat loss by evaporation of perspiration becomes by far the most important means of preventing a rise in body temperature. This mechanism is endangered, however, when the relative humidity of the atmosphere is high. At an environmental temperature of 85°F, for a naked man (lower for a clothed man), sweating begins and is necessary to control the body temperature. Continued sweating may bring ill-effects in its train. Sweat is in effect a weak solution of sodium chloride in water and the chloride of the body is depleted by excessive sweating. If water alone is drunk to relieve the ensuing thirst, the chloride loss is not made good. In such cases the mildly affected may complain of headache and inability to concentrate, fatigue, dizziness, palpitations or nausea. Physical exertion will aggravate these symptoms.

This clinical picture is usually referred to as a state of "heat exhaustion" and conditions conducive to it are not infrequently found in non-ferrous foundries. A variety of the same condition results in "heat cramps" which may follow muscular exertion in hot environments and usually affect those muscles which have been used the hardest. They are cured within a short time by drinking a saline drink.

This condition of heat exhaustion is now well known. In the past it was controlled, with some degree of success, by drinking quantities of barley water, oatmeal gruel or even beer (although the alcohol content of the last is deleterious). All these substances have a natural content of chloride. A much more efficient means of control is by provision of saline drinks. These should contain approximately 0.1 per cent sodium chloride and physiological demand may be used to determine the quantity consumed.

The use of saline drinks is now common¹⁷ in industries where there is much exposure to heat including the non-ferrous foundry industry although under the best possible conditions in foundries, heat exhaustion should not occur. It is noted that several preparations, pleasantly flavoured, are available.

FIRST AID INCLUDING TREATMENT OF MOLTEN METAL BURNS

Recently an interdepartmental committee has considered the contents of official first aid boxes and the most suitable method of basic first aid treatment applied in factories as a whole. While the problems of this type in non-ferrous foundries are different from the general run of factories with a greater likelihood of more serious accidents and especially a problem from molten metal burns, it would be inappropriate to anticipate decisions. Moreover, the problem of treatment of molten metal burns has been reviewed recently by the Joint Standing Committee on Conditions in Iron Foundries, and for convenience the relevant passage which applies equally to non-ferrous foundries is reproduced from paragraph 62 of that Report:

"The accident rate in the founding industry is high and we wish to emphasise the need for having in each factory adequate facilities for rendering skilled first-aid treatment. The larger and more progressive firms have well-equipped ambulance rooms or surgeries under whole or part-time medical and whole-time nursing supervision. This is the best arrangement both for the management and the workers, because in many ways it saves manpower, time, money and even life. The smaller firms would be well advised to institute such medical and nursing services on a relatively more modest scale. But where only the main requirements prescribed by law are available, i.e. first-aid boxes in charge of first-aid workers, it is essential that the latter should be specially trained in the first-aid treatment of molten metal burns.

We have been told that the molten metal burns (which form a large proportion of all foundry accidents) have certain features which call for early surgical treatment (excision and skin grafting) in hospital by a skilled team of surgeons. Further, that when the burns are treated in this way, the time lost from work is reduced to a minimum. We recommend that the question of establishing special teams for the treatment of burns be considered by the hospital authorities in all areas where there are concentrations of foundries. Excellent services have been established in Birmingham (at the Birmingham Accident Hospital) and also in Glasgow. First-class work in the treatment of burns is also being done at the Luton and Dunstable Hospital. There may well be up-to-date facilities for the treatment of burns at other hospitals, but we have no first-hand knowledge of them.

We are also advised that the best first-aid treatment for molten metal burns is one that does not interfere with subsequent hospital treatment. Briefly it consists in the application of a dry sterilised dressing to the injured area, the institution of first-aid measures for the treatment of pain and shock and in the rapid transfer of the patient to hospital."

REFERENCES

1. *First Report of the Joint Standing Committee on Safety, Health and Welfare Conditions in Non-Ferrous Foundries*. H.M. Stationery Office, London, 1957.
2. *The Casting of Brass Regulations*, 1908 (S.R. and O., 1908, No. 484).
3. Turner, D., Lawrie, W. B., Eyden, A., and Edwards, A. "The Thermal Environment in Non-ferrous Foundries". *Metal Industries*, Vol. 88, Nos. 19 and 20, 1956.
4. McLaughlin, A. I. G. *Industrial Lung Diseases of Iron and Steel Foundry Workers*. H.M. Stationery Office, London, 1950.
5. Harding, H. E., and McLaughlin, A. I. G. "Pulmonary Fibrosis in Non-ferrous Foundry Workers". *Brit. J. Industr. Med.*, 1955, 12, 92.
6. Stalker, W. W. "A Study of the Hazards of Exposure to Metallic Fumes and Dust in Brass Foundries". *J. Ind. Hyg. and Toxic.* 1947, 29, 96.
7. Lauer, D. J. "Clinical Lead Intoxication from Brass Foundry Operations". *Arch. Ind. Health*, 1955, 11, 107.
8. Lane, R. E., and Campbell, A. C. P. "Fatal Emphysema in Two Men Making a Copper Cadmium Alloy". *Brit. J. Industr. Med.*, 1954, 11, 118.
9. Bonnell, J. A. "Emphysema and Proteinuria in Men Casting Copper Cadmium Alloy". *Brit. J. Industr. Med.*, 1955, 12, 181.
10. *Pneumoconiosis* (Leroy, U., Gardiner, Memorial Volume). Paul, B. Hoeber Inc., New York, 1950.
11. Sneddon, I. B. "Berylliosis: A Case Report". *British Medical Journal*, 1955, June 18, p. 1448.
12. Doig, A. T., and Duguid, L. N. *The Health of Welders*. H.M. Stationery Office, London, 1951.
13. The Institute of Welding. *Health and Safety in Welding*. London, 1956.
14. Bradford Hill, A., Hunter, D., et al. "Risk of Fluorosis in Magnesium Foundries". *Brit. J. Industr. Med.*, 1947, 4, 216.
15. M.R.C. Memorandum No. 22. *Industrial Fluorosis*. H.M. Stationery Office, London, 1949.
16. McLaughlin, A. I. G., and Harding, H. E. "Pneumoconiosis and Other Causes of Death in Iron and Steel Foundry Workers". *Arch. Ind. Health*, 1956, 14, 350.
17. Stewart, D. "Therapeutic Uses of Sodium Chloride in Industry". *Brit. J. Industr. Med.*, 1945, 2, 102.
18. Turner, D. "A Study of the Thermo Environment in Non-ferrous Foundries". *Brit. J. Industr. Med.*, 1957, 12, 177.
19. *First Report of the Joint Standing Committee on Conditions in Iron Foundries*. H.M. Stationery Office, London, 1956.
20. Morris Kleinfeld, et al. "Health Hazards Associated with Inert Gas Shielded Metal Arc Welding". *Arch. Ind. Health*, 1957, 1, 27.